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Global Radiation Belt Modeling: Combined MHD, Ring Current and Test-Particle Simulations

Kareem A. Sorathia*(1), Aleksandr Y. Ukhorskiy(1), Viacheslav G. Merkin(1), Michael J. Wiltberger(2), John Lyon(3), Seth G. Claudepierre(4), and Joseph F. Fennell(4)
(1) Applied Physics Laboratory Johns Hopkins, Laurel, MD, United States
(2) National Center for Atmospheric Research, High Altitude Observatory, Boulder, CO, United States
(3) Dartmouth College, Hanover, NH, United States
(4) The Aerospace Corp, Los Angeles, CA, United States

Extended Abstract

During geomagnetic storms the intensities of the outer radiation belt electron population can exhibit dramatic variability. In the main phase electron intensities exhibit deep depletion over a broad region of the outer belt. The intensities then increase during the recovery phase, often to levels that significantly exceed their pre-storm values. In this study we analyze the depletion, recovery and eventual enhancement of radiation belt intensities during the 2013 St. Patrick's day geomagnetic storm. We simulate the evolution of the high-energy electron population comprising the outer radiation belt using our newly-developed test particle radiation belt model (CHIMP) based on a hybrid guiding-center/Lorentz integrator and electromagnetic fields derived from a coupled 3D ring current and global MHD simulation (LFM-RCM). Our approach differs from previous work in that we use MHD information to identify regions of strong, bursty, and azimuthally localized Earthward convection in the magnetotail where test particles are then seeded. In other words, magnetospheric electromagnetic fields inform *how* test-particles evolve and the plasma flow informs *where* and *when* new test-particles are created. This is key to reproducing injection of energized plasma sheet electrons into the outer belt.

We address two science questions: 1) what are the relative roles of magnetopause losses and transport-driven atmospheric precipitation in the radiation belt depletion during the storm main phase? and 2) to what extent can enhanced convection/mesoscale injections account for the radiation belt buildup during the recovery phase? Our analysis is based on long-term model simulation and the comparison of our model results with electron intensity measurements from the MAGEIS experiment of the Van Allen Probes mission. We show that our model is able to reproduce meaningful qualitative and quantitative agreement with the MAGEIS data.